METEOR-Berichte

Overflow, Circulation & Biodiversity

Cruise No. M85/2

August 05 – August 25, 2011
St. John‘s (Canada) – Reykjavik (Iceland)

J. Karstensen

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Table of Contents

	page
1 Summary	3
2 Participants	4
3 Research Program	4
4 Narrative of the Cruise	5
5 Preliminary Results	8
5.1 CTD Observations	8
5.2 ADCP observation	14
5.3 Oxygen titration	17
5.4 Mooring operations	19
5.5 DVS Meteorological and Surface Under-way Data	22
5.5 CFC/SF6 Sampling	26
5.6 Argo float deployments	27
6 Ship's Meteorological Station	28
7 Station List R/V METEOR M85/2	30
8 Data and Sample Storage and Availability	32
9 Acknowledgements	32
10 References	32

1 Summary

The R/V METEOR M85/2 expedition was carried out jointly by the GEOMAR and the Institut für Meereskunde at the KlimaCampus of the University of Hamburg. A colleague of the U.K. Lowestoft Laboratory of CEFAS, U.K., and eight students from the Universities of Kiel, Hamburg and Bremen, and from the Technical University of Tallinn, Estonia, and Princeton University, U.S. participated in the cruise and supported the field work conducted. The main objectives of the cruise were related to studies on water mass transformation processes and transports in the northern North Atlantic. During the cruise the following objectives where achieved:

1. Installation of a pilot-mooring array to study the export of deep waters from the Labrador Sea through Flemish Pass
2. Redeployment of a mooring in the Central Irminger Sea (CIS), including the installation of two new types of open ocean data telemetry systems
3. Recovery of three (DS5, DS6, DS7) and redeployment of five (UK1, UK2, F2, G1, DS2) moorings related to study mixing and entrainment processes in the Denmark Strait overflow
4. Acquisition of synoptic hydrography/currents/oxygen/CFC data at key sections in the overflow region
5. Deployment of two Argo floats (with oxygen sensors)

The scientific aspects of this work were supported through the BMBF project "North Atlantic" and the EU FP7 project THOR.

Zusammenfassung

Die Reise M85/2 der R/V METEOR wurde federführend vom GEOMAR und dem Institut für Meereskunde des KlimaCampus der Universität Hamburg durchgeführt. Ein Kollege des CEFAS Institut U.K. Lowestoft Laboratory sowie acht Studenten der Universitäten in Kiel, Hamburg, Bremen, Tallinn (Estland) und Princeton (USA) unterstützten die Arbeiten an Bord. Zusammenfassend lässt sich sagen, dass die folgenden Arbeiten erfolgreich durchgeführt wurden:

1. Installation von zwei Verankerungen im Flemish Pass welche den Export von Wasser aus der Labrador See südwärts vermessen sollen.
2. Bergung und Wiederauslegung eine Verankerung in der zentralen Irminger See. Zudem wurde die Verankerung mit neuen Techniken zur Datenfernübertragung ausgerüstet.
3. Aufnahme von drei (DS5 – DS7) und Auslegung von fünf (UK1, UK2, F2, G1, DS2) Verankerungen die den Transport und die Änderung in der Charakteristik des Wassers aus dem Dänemarkstrassen Overflow aufzeichnen.
4. Hydrographische und Sauerstoff/CFC Vermessung von ausgewählten Schnitten, meist senkrecht zum Hang an verschiedenen Breitengraden.
5. Ausbringen von zwei profilierenden Driftern des Argo Programms.

Die wissenschaftlichen Aspekte der Reise wurden über das deutsche BMBF Projekt „Nordatlantik“ sowie über das FP-7 Projekt „THOR“ der Europäischen Gemeinschaft gefördert.

2 Participants

Name	Discipline	Institution
Dr. Johannes Karstensen	Chief scientist	GEOMAR
Dr. Michael Brüdgam	CTD/(l)ADCP watch	IfM-ZMAW
Andrew Budnick	Student, Oxygen titration	PU
Mateusz Cienciala	Student, CFC/SF6	IUPHB
Ulrich Drübbisch	Mooring, logistics	IfM-ZMAW
Carolin Hauer	Student, CFC/SF6	IUPHB
Dr. Kerstin Jochumsen	CTD/(l)ADCP watch	IfM-ZMAW
Julia Köhler	Student, CTD/(l)ADCP watch	IfM-ZMAW
Uwe Koy	Mooring, logistics	GEOMAR
Taavi Liblik	Student, CTD/(l)ADCP watch mooring	TTU
Wiebke Mertens	CTD technician	GEOMAR
Katharina Müller	Student, Oxygen titration	GEOMAR
Daniel Madsen	Public outreach THOR	Alphafilm
Neil Needham	Mooring, logistics	CEFAS
Hanna Paulsen	Student, CTD/(l)ADCP watch	IfM-ZMAW
Norbert Verch	CTD/(l)ADCP watch, Salinometer	IfM-ZMAW
Andreas Raeke	Meteorology	DWD

GEOMAR:	Helmholtz-Zentrum für Ozeanforschung Kiel, Kiel, Germany
IfM-ZMAW:	Institut für Meereskunde, KlimaCampus, University of Hamburg, Hamburg, Germany
IUPHB:	Institut für Umweltphysik, University of Bremen, Bremen, Germany
CEFAS:	Centre for Environment, Fishery and Aquaculture Science, Lowestoft, U.K.
PU:	Princeton University, Princeton, USA
TTU:	Talinn Technical University, Talinn, Estonia
Alphafilm:	Alphafilms Aps., Copenhagen, Denmark
DWD:	Deutscher Wetterdienst, Hamburg, Germany

3 Research Program

The research program of the R/V METEOR M852 cruise consisted of the acquisition of oceanographic data related to the following science themes:

- Transport, properties and transformation of the Denmark Strait overflow waters
- Convection and transformation of water masses in the Irminger Sea and impact on biogeochemical variables
- Convection, water mass transformation and export of water masses from the Labrador Sea

More specifically our focus was on the following processes related to water mass transformation and transport in the northern North Atlantic:

- Estimating the export of deep waters from the Labrador Sea through Flemish Pass by installation of a pilot-mooring array in the Flemish Pass
- Estimate convection depth and water mass changes in the Central Irminger Sea through moored observations
- Estimate the mixing and entrainment of ambient waters in the Denmark Strait overflow from instrumentation moored along the Greenland Shelf and in Denmark Strait
- Acquire quasi synoptic hydrographic sections through the overflow waters

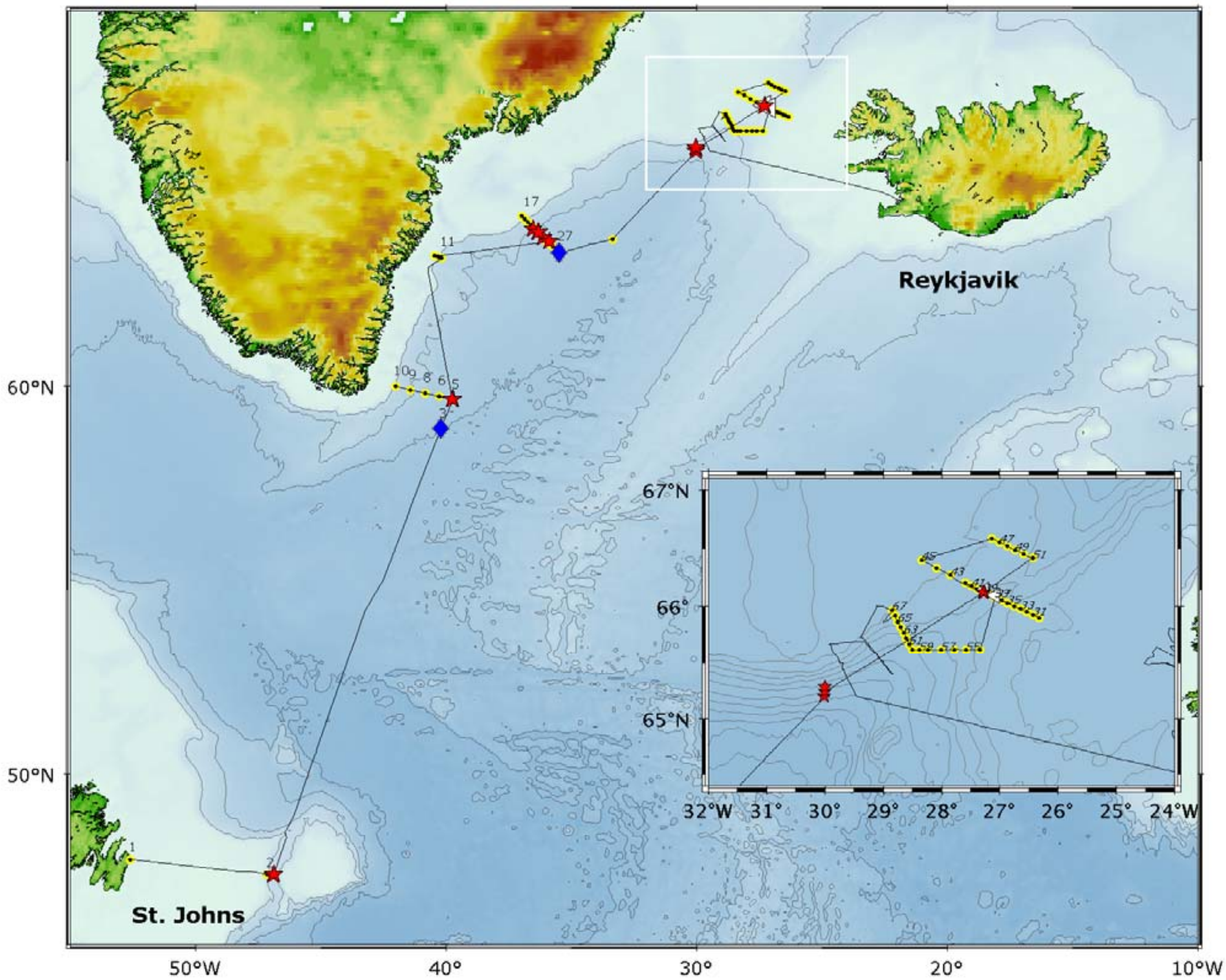

Fig. 3.1 Track chart of R/V METEOR Cruise M85/2. Yellow/black dots indicate CTD+ casts, rhomb symbols Argo float deployments, stars mooring operations, white triangle PIES deployments. Selected station numbers are given for reference.

4 Narrative of the Cruise

R/V METEOR sailed on the 5. August 2011 at 09:04 local time in St. Johns, Newfoundland, Canada. First a CTD/O2/lADCP station was made just 10nm off the harbour at the Canadian time series station "Station 27" at 47° 32.80'N/052° 35.20W, water depth 176m. The CTD with rosette water sampler from the Institut für Meereskunde ZMAW, Hamburg, was used with double T and C sensors and a single oxygen (O2) sensor. After this first station we installed some additional sensors (PAR/SPAR and fluorometer) from the R/V METEOR board CTD and we also used the R/V METEOR SBE-11 deck unit (as it had the S-PAR port).

We headed eastward to our first mooring-related working area, Flemish Pass. Here, two moorings were deployed, the FP1-11 (2 RCM8, 2 MC) and the FP2-11 (75kHz ADCP, 1 MC). This mooring installation is a pilot-array to test the feasibility of measuring the flow strength and characteristics through Flemish Pass. Just a few days before our cruise, a detailed CTD survey of the Flemish Pass area was performed during M85/1 (chief scientist D. Kieke, IUPB) and therefore we recorded only one CTD/O2/CFC/lADCP (from now on CTD+) cast, at the FP2-11 location. Despite high seas (+4m) and strong winds (up to 8 Bft) the mooring deployments went well. We left the Flemish Pass working area and headed northward, for the southern Irminger Sea. Because of strong head winds and waves, the 900nm transit took more than 5 days, from 7. August to 12. August. The thermosalinograph did not work properly during parts of this transit, and only after several attempts it could be repaired. Apparently a small obstacle (maybe a shell) was blocking a tube and measurements were not of use. During transit, the telemetry systems of the THOR pop-up frame and the Molab surface telemetry were successfully tested. The transit was also used for seminars on different topics and for a safety drill (man over board manoeuvre).

The winds and waves calmed down with our arrival at the central Irminger Sea working area. On the 12.08.2011 early morning an Argo float (with O2 sensor) was launched near the CIS mooring site, accompanied with a CTD+ cast for later calibration of the float data. The recovery of the CIS mooring started at 08:00LT and after 2 hours all instruments were safely recovered on deck. Five CTD+ cast towards the Greenland coast followed the recovery to obtain information about the hydrography and currents at the western boundary of the Irminger Sea. On the next morning, the 13.8.2011, the CIS-11 mooring was deployed within 4hours time, without problems and in perfect weather conditions.

From the CIS working area we headed Northwest, towards the Greenland Coast to recover an ADCP lander (UK-ADCP-07) that was installed here in 2007 by Maria S. Merian to measure freshwater fluxes along the shelf break. At night a small sailing yacht was spotted at the horizon and we had a short communication with its crew, which turned out to be German and sailing to Reykjavik. We studied different ice charts and found that the recovery of the ADCP lander might be possible. Approaching the site we found more drifting brash ice than expected and, as RV METEOR does not have the appropriate ice class, the search for the lander was terminated. A repeat CTD+ section was performed instead, covering the shelf break to the ice edge. The EM122 logging was switched on, as requested by the next leg (M85/3) chief scientist S. Brix, who will also be responsible for the data processing.

The next working area was the "Angmagssalik array", located at approximately 63°N. On the 15. August 2011 all four moorings of the Angmagssalik array (UK1-10, UK2-10, F2-10, G1-10) were recovered. In addition, the G1-11 mooring was deployed. It was a very clear day and although being more than 90nm away from the coast, we had a clear view on an impressive Greenland mountain massive on the horizon. Releases were tested on one deep CTD+ cast and a CTD+ section was made along the Angmagssalik array. On the 16. August the three remaining moorings of the Angmagssalik array (UK1-11, UK2-11, F2-11) were deployed.

Our last working area, the Denmark Strait, was reached on the 18. August 2011. We first recovered three ADCP/MC mooring (DS5-10, DS6-10, DS7-10). This array of ADCPs, with only 2nm apart from each other, was installed to collect data to study sub-mesoscale processes in the overflow region. As a contribution to this experiment, a 14 hours CTD/lADCP Yo-Yo station was made at the central DS06 location. For the Yo-Yo station, the CTD rosette was undulating between 700m and the bottom (approx. 1400m), recording 29 times high resolution profiles of temperature, salinity, oxygen, and turbidity and current. The data revealed the amazing variability at this location.

Our last mooring operation was the recovery of the DS2-10 mooring, located at the sill depth of Denmark Strait. The acoustic tracking of the release worked well and confirmed release. Unfortunately the mooring did not come to the surface, and several attempts were not successful in bringing the ADCP and MC up. We surveyed the area with the EM122, with the hope to identify traces of the mooring in the echo sounding, but the resolution was too coarse. We decided to continue CTD work along the DS section overnight and return to the DS2 site on the next morning to dredge for the mooring. At night we also passed-by the DS2 site and the release answered promptly, so we still could be sure that the mooring was at place. Next morning we made an acoustic survey triangulation and confirmed the estimated position from the last years' deployment protocol. Then we started dredging by deploying a steel wire on a 1km diameter 1/2 circle around the mooring position and slowly pulling it in, but without success. A dredging on a smaller diameter (500m) and a more closed circle around the mooring failed as well. The very likely problem is that the whole mooring sticks out only by 7 to 8m from the ground, which is probably not high enough to be caught by the dredge wire. Using equipment of the recovered DS5 to DS7 array, which was planned to go to the Faroe-Shetland Channel, a "substitute" mooring (DS2-11) was assembled and deployed next to the DS2-10. After this deployment, two PIES were deployed close to the DS2 and DS1 locations.

The remaining expedition time was used for CTD+ surveys in the overflow at different distances from the sill. The winds and waves picked up again, but the program was not much affected. For the last CTD section (station 78 to 86) we used the R/V METEOR CTD system, mainly to prepare the system for use by our colleagues during M85/3. The change of the CTD system went very well and the R/V METEOR CTD seemed to operate very well. The salinity calibration of the bottle samples at IfM Hamburg after the cruise revealed a good condition and stability of the sensors. The last CTD/O2 station was completed on the morning of the 24. August 2011. The scientific program ended when entering the Icelandic 12 nm zone and all logging was switch off (EM122, DVS and ADCP). R/V METEOR was moored alongside the pier in Reykjavik on the 25. August 2011 at 09:20 and the M85/2 expedition ended.

5 Preliminary Results

5.1 CTD Observations

(K. Jochumsen ZMAW, J. Karstensen GEOMAR)

CTD data was obtained with two Sea-Bird SBE 9 system. Station 1 to 77 were recorded with a system owned by the University of Hamburg (ZMAW). The CTD was equipped with one single Paroscientific digiquartz pressure sensor (SN 50633). Double sensor packs were used for temperature and conductivity measurements (primary sensors: SN 1294 and SN 1106; secondary sensors: SN 4324 and SN 1329). In addition, an SBE 43 oxygen sensor (SN 1761), chlorophyll (WET labs, FLNTURTD SN 1713) and radiance sensors (PAR Biospherical Licor Chelsea Sensor SN 70279) were attached to the CTD. For calibration of the radiance, surface measurements were carried out with a separate sensor, attached to the vessels deck (Surface Irradiance Sensor SN 20353). The chlorophyll and radiance sensors were kindly provided by R/V Meteor. The instrument distance above the sea floor was derived from an altimeter (SN 885) attached to the CTD frame. The CTD rosette had 9 Niskin bottles (5litre each) and water samples were collected from selected depth levels. In the laboratory, the data from the CTD cast was converted by an SBE 11 plus deckunit, and recorded with a standard Windows PC, using the Seasave software (V 7.21d).

And the end of the cruise we completely changed the CTD system, using the R/V METEOR system (St. 78 to 86). The R/V METEOR CTD had the following sensors installed: Paroscientific digiquartz pressure sensor SN 117527, SeaBird temperature (03P5272 primary; 03P5283 secondary), SeaBird conductivity (043732 primary; 043734 secondary) and single SeaBird oxygen sensor (SN 431812). The Wetlabs chlorophyll and the Chelsea PAR sensors were the same as for the ZMAW system. The ships altimeter was SN 51861. The R/V METEOR rosette sampler had 24 Niskin bottles with 10 litre volume. The oxygen sensor calibration of the Meteor CTD was done with the oxygen samples analysed on board (as for the other system), while the salinity samples were packed and measured at the University of Hamburg after the cruise.

The processing and conversion of all CTD raw data was done with the “SBE data processing” program package (V 7.21d). The calibration of conductivity sensors was done using salinity values from bottle samples, which were measured by an Autosal Salinometer (SN 59839). The calibration results are summarized in the table below. The primary sensor was used for profile 1 to 77. Overall 141 calibration points from the Salinometer measurements were obtained for the calibration. To account for possible outliers in the salinometer data, 33% of the largest differences between CTD and bottle samples were discharged and not considered for calibration. The projection from the bottle stop of the up- to the downcast was done by searching for similar potential temperatures within 30dbar pressure internal around similar pressure horizons between up- and downcast. For the critical loop edit velocity 0.01 m/s was used. The conductivity calibration of the downcast data was performed using a 1st order linear fit with respect to temperature, pressure and conductivity. See table 5.1.1. for a summary on the sensors used and calibration applied.

For Chlorophyll and PAR no extra calibration was done but the manufacturers calibration was used.

During the cruise uncalibrated data with a vertical resolution of 10dbar was transferred to the CORIOLIS Data Center, Brest, France for use in operational services.

Table 5.1.1: Summary of calibration information for the CTD system operated during R/V METEOR M85 (calibration September 13, 2011, Software version 0.19)

CTD System ZMAW (Profile 1 to 77)		
P calibration or check date :	1992/11/20	
Pressure Deck offset applied to data	**-1.215**	
Sensor pair used for calibration	**1**	
Pressure S/N	**50633**	
Temperature S/N	**1294**	*4324*
Conductivity S/N	**1106**	*1329*
Oxygen S/N	**1761**	*Primary only*
Calibration results system #1 (used for final data)		
C down calibration string:	**0.0062451+1.0226e-007*p+0.00021225*t-0.0021875*c**	
misfit	**0.0007399 PSU**	
O down calibration string :	**21.2879+0.0011694*p-0.42224*t+0.004616*o**	
misfit:	**1.2871 µmol/kg**	
C up calibration string:	**0.0092645+1.1337e-007*p+0.0002942*t-0.0032115*c**	
misfit:	**0.00045481 PSU**	
O up calibration string:	**16.7716+0.00042342*p-0.57036*t+0.018961*o**	
misfit:	**1.1066 µmol/kg**	
Other sensors		
WET labs, FLNTURTD	**SN 1713 – no extra calibration performed**	
PAR Biospherical Licor Chelsea Sensor	**SN 70279 – no extra calibration performed**	

Preliminary results

Most CTD stations were acquired along sections that had been surveyed in the past, so called "VEINS" sections. Section A (Figure 5.1.1) is located in the central Irminger Sea, turning from the CIS mooring toward the Greenlandic coast. Along this section we observed warm, salty Atlantic water near the surface while at intermediate and deeper depth (approximately 1500-3000 m) the overflow waters can be identified.

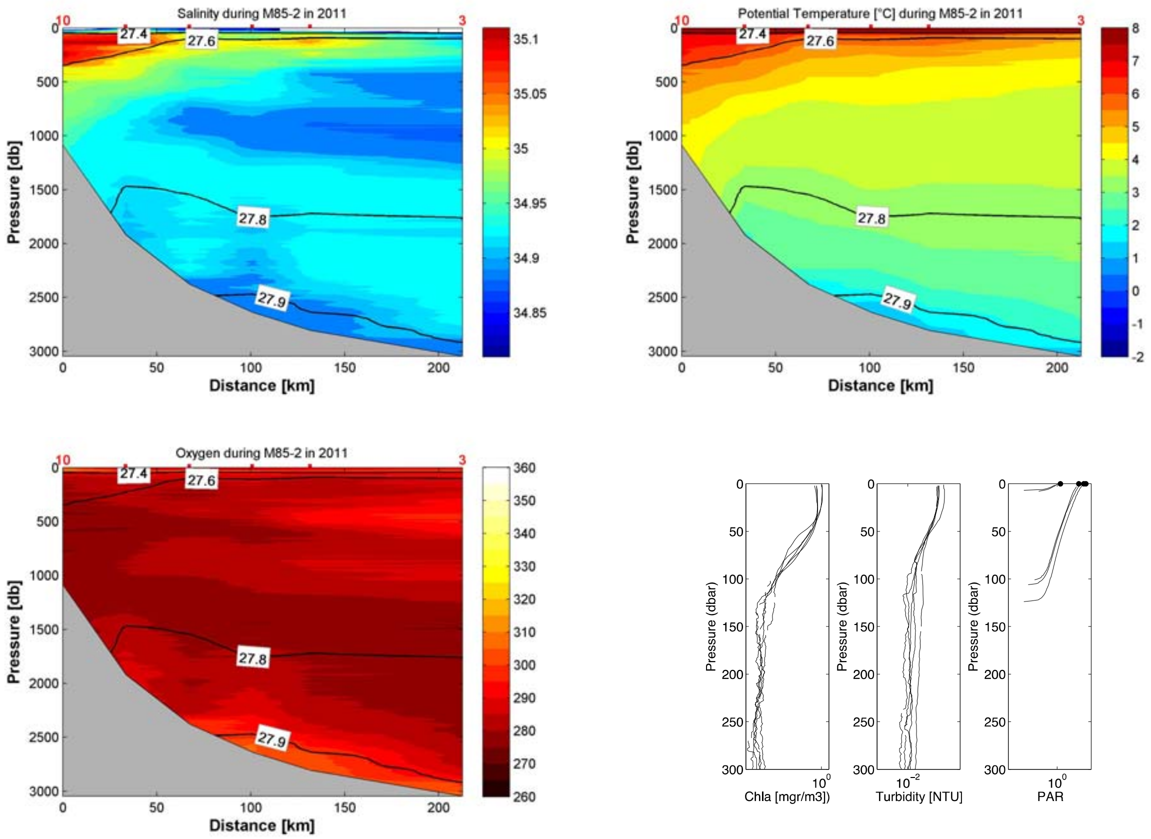

Fig. 5.1.1 Section A: (upper left) Salinity section, (upper right) potential temperature section, and (lower left) dissolved oxygen section from CIS mooring to the Greenlandic coast. In the lower right panel the upper 300m profile data (note x-axis is in logarithmic scale) for Chlorophyll-a from Fluorescence, Turbidity and Photosynthetically Active Radiation (PAR) is shown. The black dots in the PAR plot Indicate the mean surface PAR as measured with the companion sensor during the cast.

Section B (Fig 5.1.2) was located on the Greenland shelf break. At the shallowest station near the coast, the surface water was cold and fresh, due to the East Greenland Current and local ice melt. Only 4 casts were carried out on this section, since the ice conditions did not allow a further course towards the coast.

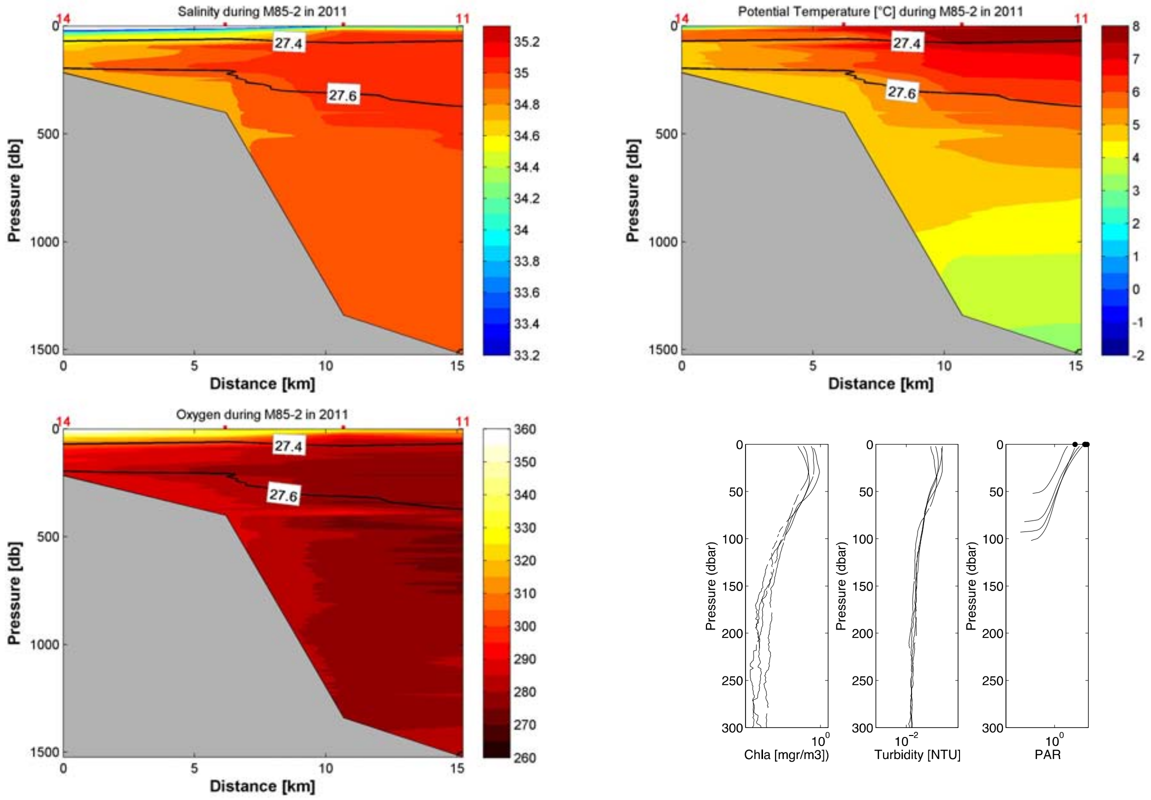

Fig. 5.1.2 Section B: (upper left) Salinity section, (upper right) potential temperature section, and (lower left) dissolved oxygen sections. In the lower right panel the upper 300m profile data (note xaxis is in logarithmic scale) for Chlorophyll-a (via Fluorescence), Turbidity and Photosynthetically Active Radiation (PAR) is shown. The black dots in the PAR plot indicate the mean surface PAR as measured with the companion sensor during the cast.

The purpose of section C was not only to repeat earlier measurements, but also to calibrate mooring data from instruments deployed nearby. The section is located near the town of Angmagssalik in northeastern Greenland. The temperature distribution (Figure 5.1.3) shows again Atlantic water at the surface and overflow water at the bottom layer. The overflow at this location was less diluted and the potential density anomaly exceeded 28 kgm^{-3}.

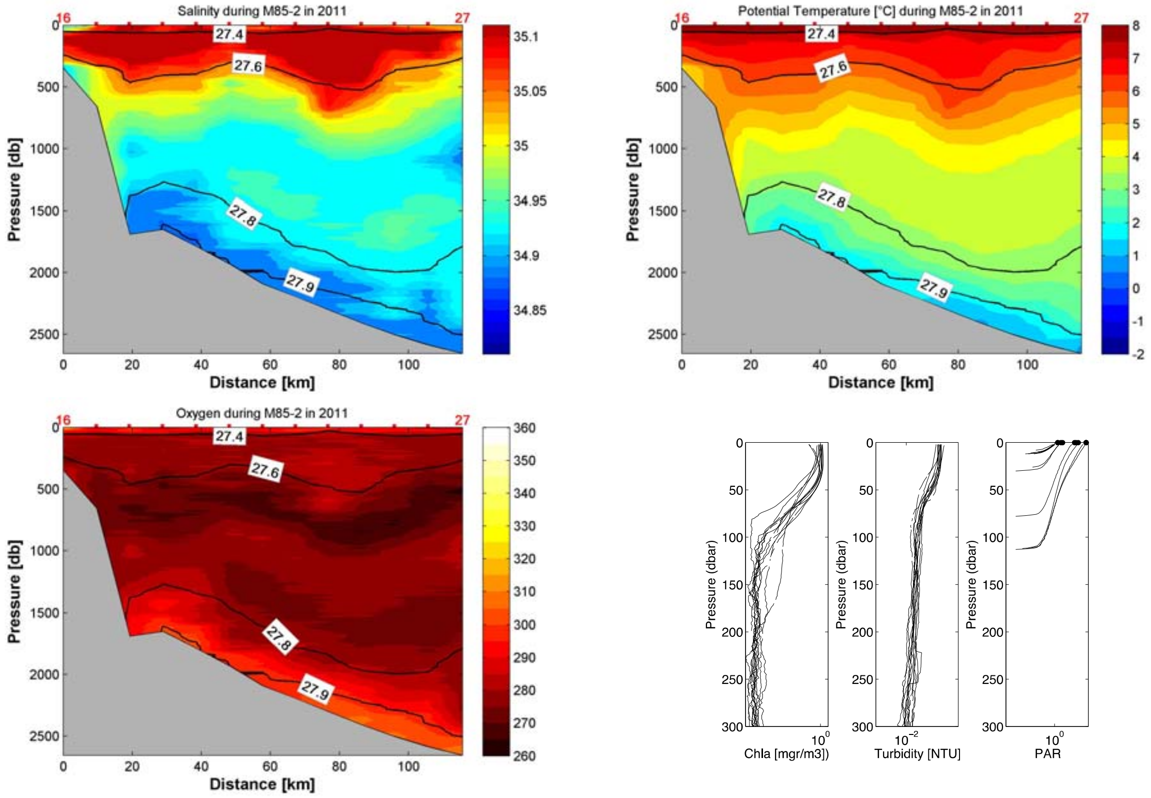

Fig. 5.1.3 Section B: (upper left) Salinity section, (upper right) potential temperature section, and (lower left) dissolved oxygen sections. In the lower right panel the upper 300m profile data (note xaxis is in logarithmic scale) for Chlorophyll-a (via Fluorescence), Turbidity and Photosynthetically Active Radiation (PAR) is shown. The black dots in the PAR plot indicate the mean surface PAR as measured with the companion sensor during the cast.

Sections D, E, F and G were carried out in Denmark Strait (Figure 5.1.4). Section D was located on the shallowest part of the passage, where the overflow waters cross the sill. While the surface layers were occupied by both warm Atlantic Water and cold East Greenland Current water, the deep passage is filled with dense overflow waters. Section E was taken north of the sill and is dominated by cold waters. Only a subsurface warm layer indicates the presence of Atlantic water at this northern section. Sections F and G were located south of the Denmark Strait sill and show the deepening of the overflow water as it enters the North Atlantic Ocean. In section F two cores of overflow water were found, both near the bottom. One was located on the shelf at 400 m depth, the other at deeper levels (900 m). At section G the overflow has descended further and occupies the depth from 1000 m to the bottom. The surface water is dominated by warm Atlantic water on both sections. From sections C to G the dilution of the overflow from entrainment is seen, as the density of the overflow core decreases.

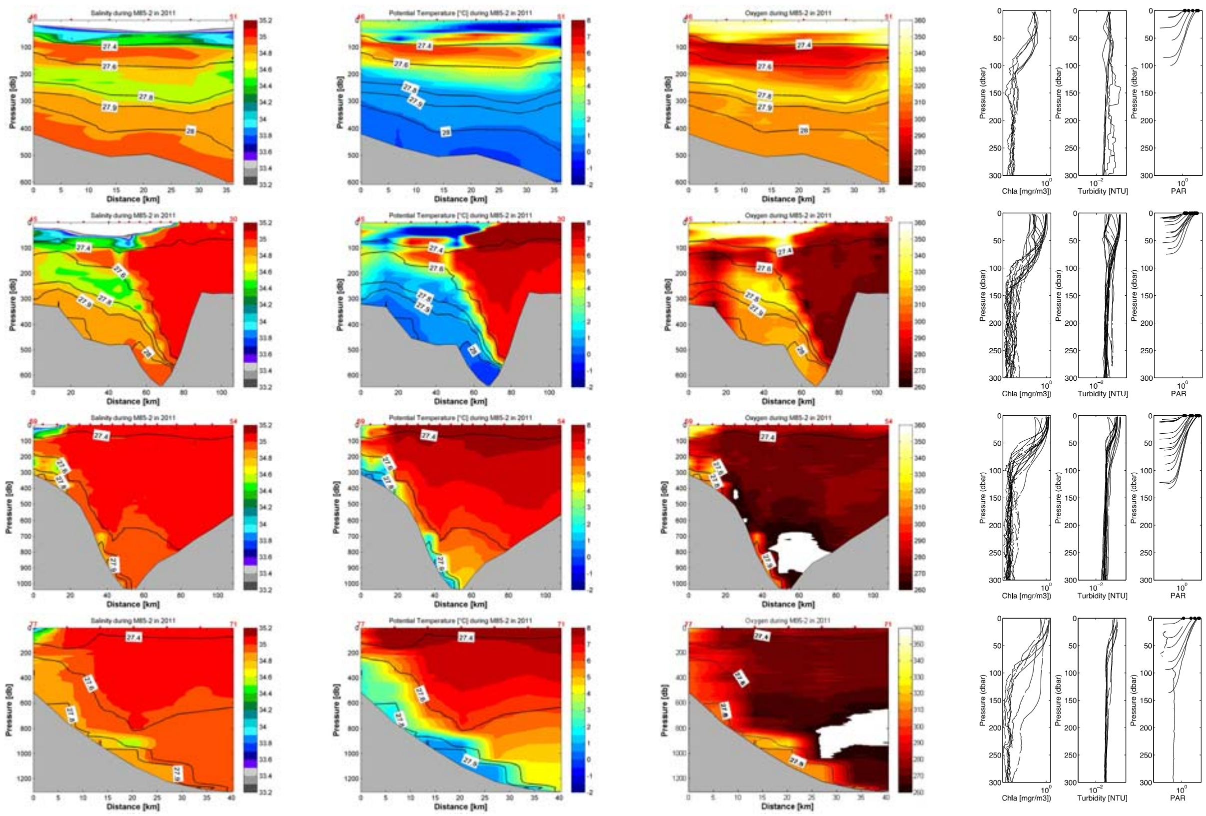

Fig. 5.1.4 (Upper to lower) Section D, E, F, G
(left to right) Salinity, potential temperature, and dissolved oxygen sections. In the right panel the upper 300m profile data (note x-axis is in logarithmic scale) for Chlorophyll-a (via Fluorescence), Turbidity and Photosynthetically Active Radiation (PAR) is shown. The black dots in the PAR plot indicate the mean surface PAR as measured with the companion sensor during the cast.

CTD Yo-Yo station

On the 18th to 19th of August 2011 a 17 hours long CTD/lADCP Yo-yo station (Station 101-129) was performed in the overflow plume, just south of the sill. The CTD was lowered 29 times at the same position and repeatedly measuring the water column from 700 m to 1300 m (sea floor).

Large variability was observed at this location from a well develop to a not any longer existing plume and visible in temperature, salinity, oxygen and density likewise (Figure 5.1.5). The observations are in line with an intense meandering of the plume.

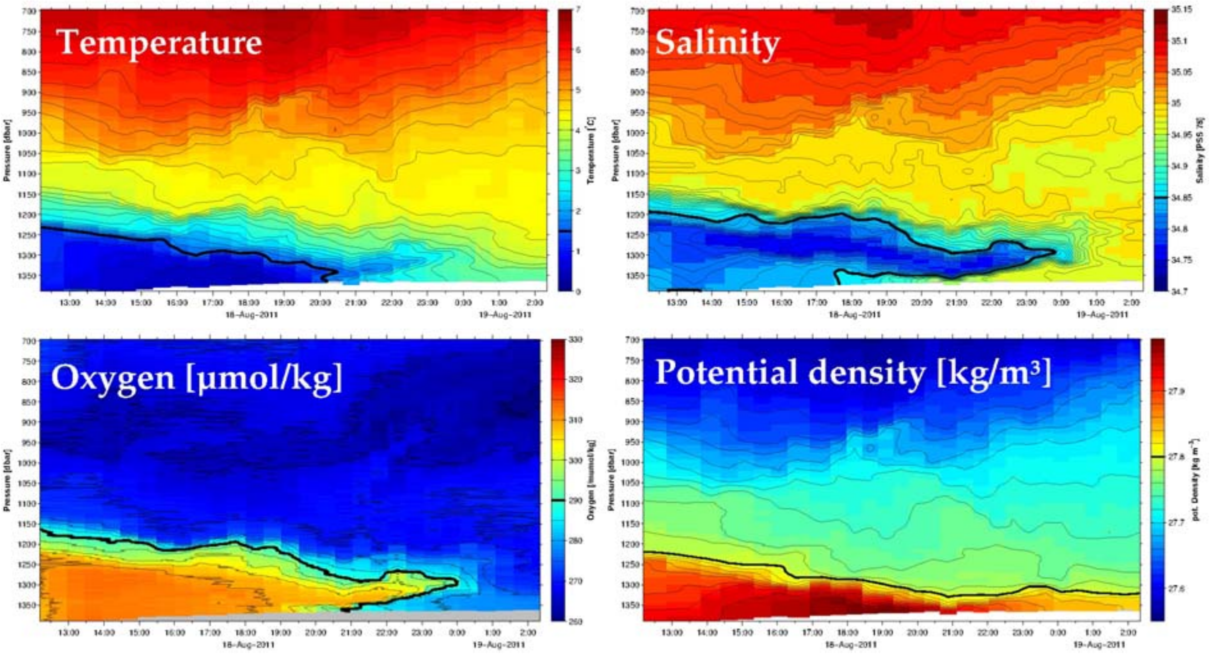

Fig. 5.1.5 (upper left to lower right) temperature, salinity, oxygen and potential density anomaly evolution at the YOYO CTD station location in the Denmark Strait overflow region. Note the bold line giving a reference surface.

5.2 ADCP observation

(H. Paulsen ZMAW & J. Karstensen GEOMAR)

Vessel mounted ADCP

Current measurements have been performed using the two RDI Ocean Surveyor (OS) instruments (38kHz and 75kHz) of the R/V METEOR. Both instruments were configured in broadband mode. The OS75 was set up to measure 8 m bin size and covered a range of 500 to 700m. The OS38 was configured to use 16m bins and covered a range down to 800 and even 1000m depth, depending on sea state and ship's speed. The OS38 was mounted in the moon pool with approximately zero degree alignment, while the OS75 was mounted at a 45 degree angle to avoid interference between the two instruments. The ADCP acquisition system was recording the ships navigational input.

Simultaneous use of the ship's Doppler log and/or echo sounder should be avoided as it degrades the velocity data. The echo sounder was turned on and off only to receive information of water depth at each CTD station. The software VMDAS was used to set the ADCP's operating parameters and to record the data. The Ocean Surveyor data conversion and final data processing was done using GEOMAR SADCP-Matlab routines. The final data were 10 minutes averages of the raw data that was recorded in „as fast as possible" mode.

Misalignment angles of the mounted devices were determined during accelerating phases of the ship (e.g. arrival/leave stations). These angles were applied to correct the data: 38kHz -1.1353° (Amplitude Factor 0.995730) and 75kHz -46.9668° (Amplitude factor 1.00004273).

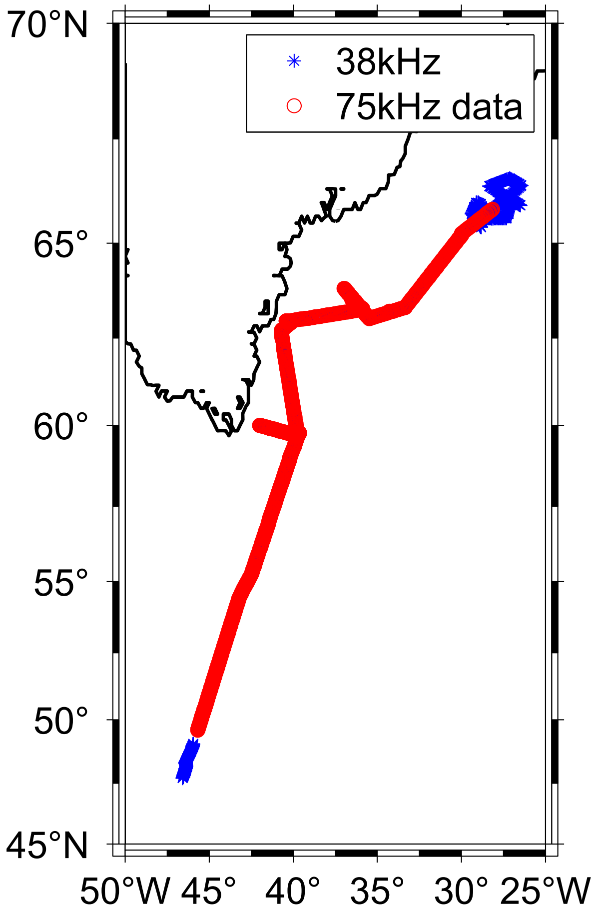

Fig. 5.2.1. Data coverage (10 minutes averages) along the track of R/V METEOR M85/2 for the 75 kHz and the 38kHz systems.

Some power outages of the ship were responsible for data loss, as the system was not immediately started again but also as the data back-up via a soft link was corrupted. This is in particular true for the 75kHz system where data loss occurred at the end of the cruise, as the back up disk system did not work properly (Fig. 5.2.1)

Lowered ADCP

Two 300kHz RDI-L-ADCP units were mounted to the CTD-Rosette for all casts made with the ZMAW CTD system. The system was not used with the Meteor rosette. The downward looking instrument was the SN 839 (master) and the upward looking was SN 6468 (slave). The ADCP instruments worked in a joint mode via the same battery supply (design GEOMAR). Batteries were typically exchanged when the voltage level dropped to around 42V. Overall the system worked well and gave good ranges (Figure 5.2.2.). For some profiles (1, 8, 9, 10, 37) position data was not available in the CTD data and had to be included from the DVS system.

The following configuration was used throughout the cruise (differences Master/Slave are indicated):

```
WV250                       ; ambiguity velocity [cm/s]
WN25                        ; number of depth cells; NBP0402
```

```
WS1000                     ; bin size [cm]; NBP0402: WS1000
WF0                        ; blank after transmit [cm]; NBP0402
WP1                        ; single-ping ensembles; NBP0402: WP3 most of the time
TP 00:00.90                ; time between pings; NBP0402
TE 00:00:01.50             ;       - time per ensemble
CF11101                    ; Flow control:
SM1 or SM2                 ; set to master (1) or slave (2)
SI0                        ; master waits 1 ensemble before sending sync puls
SA011                      ; send pulse before ensemble
(SW5500                    ; master waits .5500 s after sending sync pulse)
```

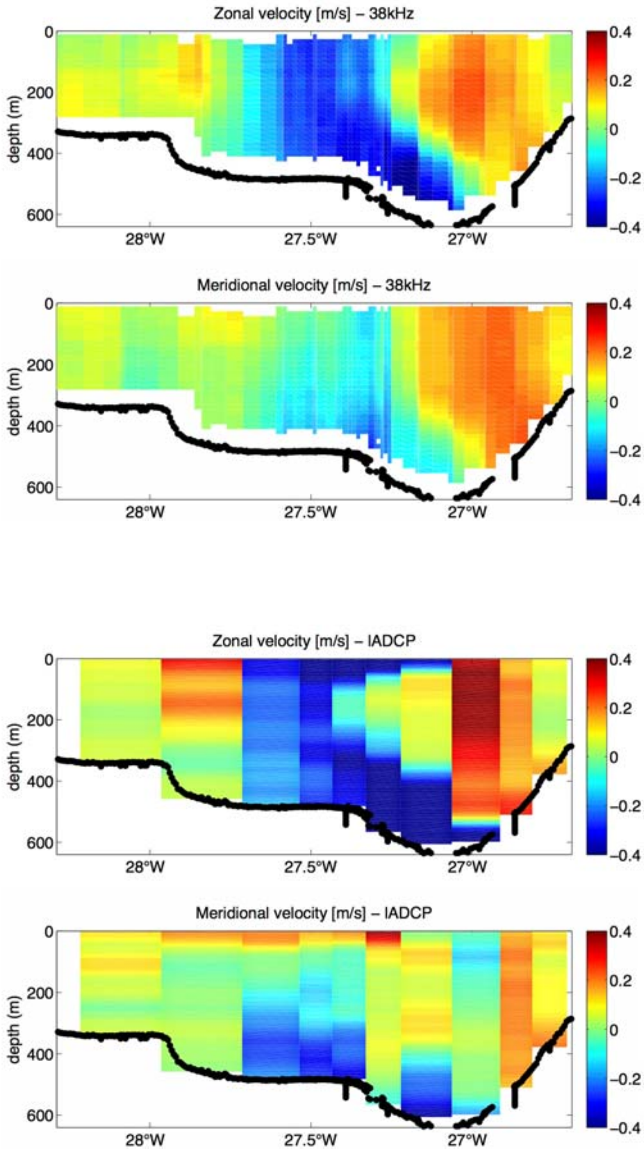

Fig. 5.2.2 Distribution of zonal and meridional velocities in Denmark Strait as recorded with : (upper 2 panels) the 38kHz ship mounted ADCP and (lower 2 panels) the lADCP system.

5.3 Oxygen titration

(A. Budnick, Princeton & K. Mueller, GEOMAR)

Methods

During R/V METEOR M85-2 oxygen titration was done primarily to calibrate the CTD oxygen sensor. At each station stop deeper than 400 m in a transect, a rosette closed a series of at most nine bottles during its ascent at different depth levels while the attached CTD made measurements.

We used the Winkler method of determining oxygen concentration, including immediate and simultaneous administration of 1 mL each of alkaline-iodide and manganese oxide solutions to water samples with chemical dispensers in a "fixing" process. The volume of the bottles was approximately 100 mL; precise volume measurements were used when calculating concentrations. These samples were then sealed and titrated with sodium thiosulfate at least a half hour but no more than eight hours after fixing. Normally, titration took place around an hour after fixing.

We used Schott's TITRONIC Universal Piston Burette for titration, with magnetic stirrer model TM96, burette tip model TZ1503 and bottle top TZ2005. The software was version 3.23. After neutralization with 1 mL of sulfuric acid measured with volumetric pipette, each fixed bottle was pretitrated with 4.00 mL of sodium thiosulfate. 1 mL of starch-iodide indicator was then added with a chemical dispenser, and titration was run to completion.

Oxygen concentration could then be calculated using the stoichiometric ratios of the reagents. Periodically, we corrected for air dissolved in reagents with a potassium iodide standard, both preprepared and mixed on-site.

Main purpose of the precise oxygen determination was the use for a subsequent CTD O2 sensor calibration. A way to verify the consistence of the oxygen determination was by means of saturation in near surface waters. In the surface (10m depth, the shallowest bottle sample depth), the water is mostly oversaturated (Fig. 5.3.1, upper). Moreover it can be seen that the depth that highly-saturated water (90%) extends down to depth of more than 500m in the far north, Denmark Strait overflow region (Fig. 5.3.1, lower).

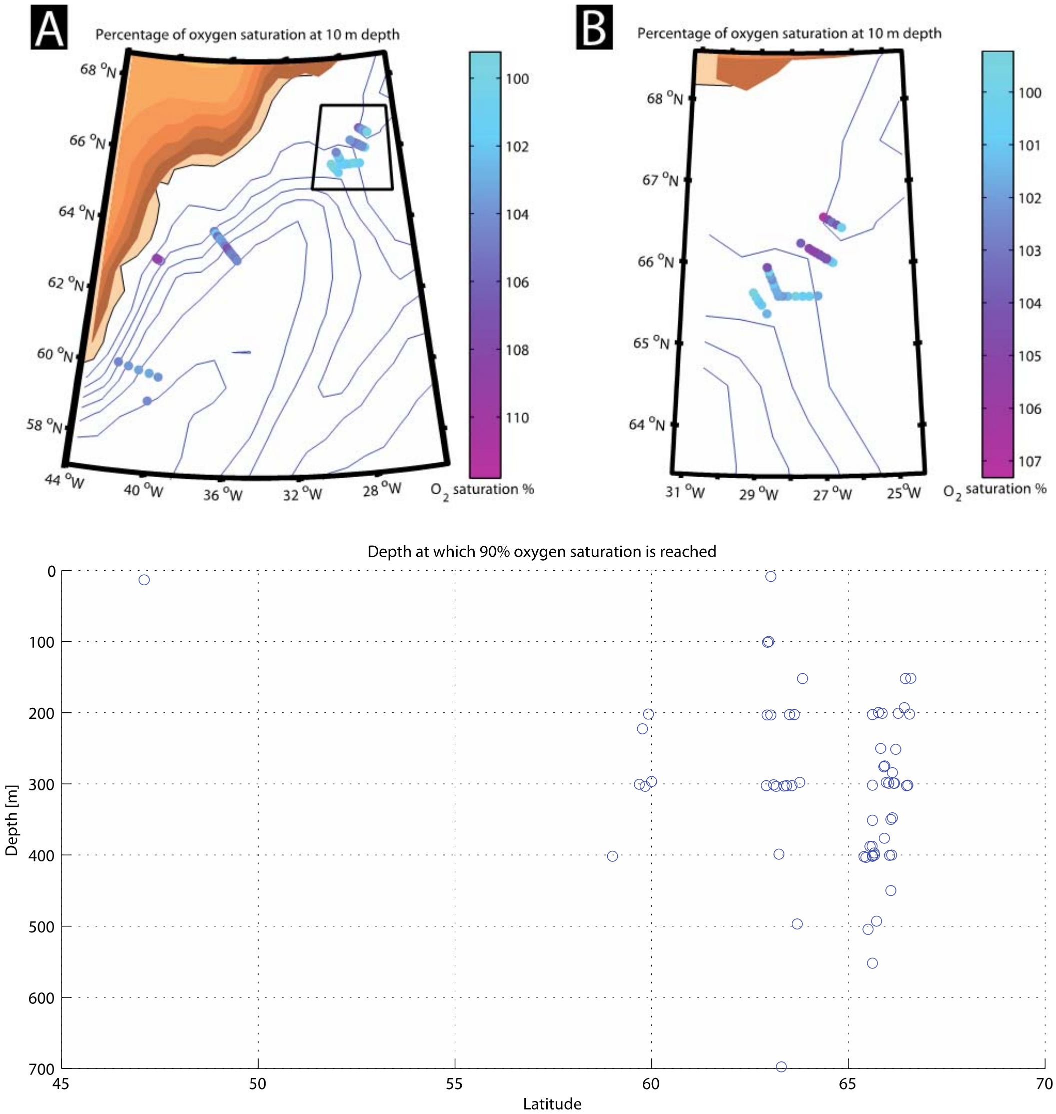

Fig. 5.3.1 (upper) A) Surface (10m depth) oxygen saturation, from manual oxygen measurements and CTD temper- ature and salinity measurements. Below 66°N, the surface oxygen saturation is generally around 102–104%, but further north, the cross sections tend to have less saturated surface water.˜B) Detail on the indicated area from left figure. In these northern sections, surface (10m depth) oxygen saturation tends to decrease to the east. The surface water in the shallowest part of the Denmark Strait has relatively high oxygen saturation.

(lower) Minimum depth at which 90% oxygen saturation is reached. In general, in the northern sections, the highly O2 -saturated water extends further down the water column than in the south. Samples were often taken at corresponding depths along a single cross section, explaining the horizontal scatter patterns.

5.4 Mooring operations

(T. Libik, TTU & J. Karstensen, GEOMAR)

A main purpose of the R/V METEOR M85/2 expedition was the re-deployment of several moorings and the deployment of two pressure inverted echo-sounders (PIES). The operations are summarized in the following table 5.4.1. and locations are shown in Figure 5.4.1.

Table. 5.4.1. Summary of mooring operations in chronological order performed during R/V METEOR M85/2 expedition.

Mooring	Operation	Date (UTC)	Position		Comment
FP1-11	Deployment	07.8.2011	47° 06.02'N	046° 51.56'W	ZMAW
FP2-11	Deployment	07.8.2011	47° 09.99'N	047° 06.18'W	ZMAW
CIS – 10	Recovery	12.8.2011	59° 41.10'N	039° 43.56'W	GEOMAR
CIS – 11	Deployment	13.8.2011	59° 41.18'N	039° 43.80'W	GEOMAR
Lander	Recovery	14.8.2011	63° 02.450'N	40° 51.370'W	CEFAS (failed)
UK2 - 10	Recovery	15.8.2011	63° 16.94'N	035° 51.88'W	CEFAS
G1 - 11	Deployment	15.8.2011	63° 21.18'N	036° 07.20'W	ZMAW
UK 1- 10	Recovery	15.8.2011	63° 29.010'N	036° 17.95'W	CEFAS
F2 – 10	Recovery	15.8.2011	63° 32.010'N	036° 29.97'W	CEFAS
F2 – 11	Deployment	16.8.2011	63° 32.8'N	036° 31.1'W	CEFAS
UK1 – 11	Deployment	16.8.2011	63° 29.0'N	036° 18.0'W	CEFAS
UK2 – 11	Deployment	16.8.2011	63° 16.93'N	035° 51.97'W	CEFAS
DS5-10	Recovery	18.8.2011	65° 11.97'N	030° 00.10'W	ZMAW
DS7-10	Recovery	18.8.2011	65° 16.93'N	030° 00.12'W	ZMAW
DS6-10	Recovery	18.8.2011	65° 14.51'N	030° 00.01'W	ZMAW
DS2-10	Recovery	19.8.2011	66° 07.23'N	027° 16.15'W	ZMAW (failed)
DS2-11	Deployment	19.8.2011	66°07,23' N	027° 16.19'W	ZMAW
DS2-PIES	Deployment	21.8.2011	66° 07.25'N	027° 16.16'W	ZMAW (PIES)
DS1-PIES	Deployment	21.8.2011	66° 05.58'N	027° 04.88'W	ZMAW (PIES)

The two moorings in the Flemish Pass (FP1, FP2) were deployed shortly after we left St. Johns and all went well. It was planned to recover the moorings during a Merian cruise in summer 2012.

The CIS mooring recovery and deployment went on smoothly. Only minor biofouling was affecting the upper most instrumentation. MicroCat 1722 had a crack-like mark on its top but no affect on data recovery. The ADCP was seriously damaged, the transducer unit was removed. Given that no corrosion was found this seem to have happen during the recovery, maybe with the release of the mooring. Although the memory card was immediately put into a dry stove, no data could be retrieved from the card. First inspection of data series showed remarkable fluctuations in pressure and therefore in conductivity and temperature as well. The latter was caused by strong current events, which forced the mooring line to the deeper layers. In most extreme cases MCs were pushed approximately 400 m deeper than their original depth.

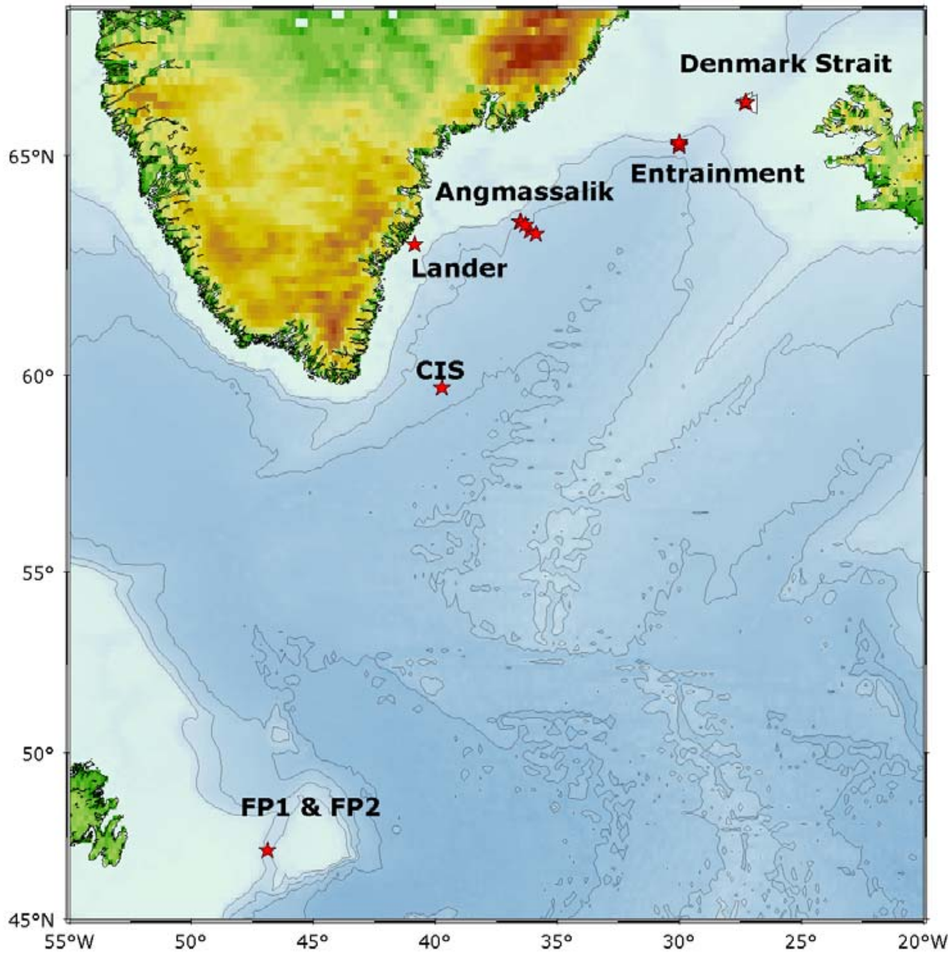

Fig. 5.4.1 Location of mooring operations during M85/2 (see associated table for positions)

An attempt was started to recover the ADCP bottom lander (Lander) that was installed off Greenland in 2007 by Maria S. Merian. Unfortunately the drifting ice did us not allow to come close enough to the lander to recover. Here a ship with ice-going capability would have been an advantage.

The moorings from the Angmassalik array (UK1, UK2, F2, G1) were all recovered without problem. The data could be read-out without a problem and first inspection showed full data coverage. The deployment went well.

The short moorings (ADCP in a 45" floatation with MCs above and below) DS5, DS6, DS7 were all recovered quickly. The data was recorded as programmed in very high resolution. Later inspection indicated some issues with the data recording close to the sea-floor, which might be contaminated by noise. No redeployment was planned during our cruise but later in 2012 with FS Maria S. Merian (MSM 21/1a).

The DS2 mooring in Denmark Strait did not appear, although the releaser responded to the commands from our deck unit. We dredged for the mooring but without success, several months later the mooring was found stranded at a beach in Norway. It turned out that it had been broken-off a few months before our attempt to recover it and we communicated only with the left-over release. One of the DS5-7 moorings, which normally would have been shipped back to Germany and the Faroe, was used as a replacement for the DS2. The DS1 was recovered and redeployed as planned.

Calibration casts for the MicroCat's deployed in all mooring we recovered were performed on the 17, 18, and 23. of August 2011 (see table 5.4.2).

Table 5.4.2. *Summary of MicroCat calibration casts during RV Metero M85/2*

Date	CTD Station	MC serial	Institute
17.08.2011	028	2256	GEOMAR
		7471	GEOMAR
		2264	GEOMAR
		2255	GEOMAR
		2933	GEOMAR
		3411	GEOMAR
		2254	GEOMAR
		2801	GEOMAR
		2799	GEOMAR
		3755	GEOMAR
		1722	GEOMAR
		2718	GEOMAR
		2252	GEOMAR
		3415	GEOMAR
		2262	GEOMAR
		3757	GEOMAR
18.08.2011	101 (with yo-yo CTD)	2942	ZMAW
		4049	ZMAW
		4295	ZMAW
23.08.2011	071	7507	ZMAW
		7508	ZMAW
		7509	ZMAW
		7510	ZMAW
		7511	ZMAW
		7512	ZMAW
		7513	ZMAW
		7514	ZMAW
		7515	ZMAW
		7516	ZMAW
		7573	CEFAS
		7575	CEFAS
		7574	CEFAS

5.5 DVS Meteorological and Surface Under-way Data

(J. Köhler ZMAW & M. Brüdgam ZMAW)

The central data distributor (DVS) system on R/V METEOR continuously records a set of oceanographic and meteorological parameters from several sensors throughout the cruise.

The sea surface salinity (SSS) and sea surface temperature (SST) were measured with a SeaCat SBE 120 that has it inlet at 4m depth. At the beginning of the cruise the SSS values were unrealistic low due to an obstacle (maybe a sea shell) that stuck in the device until it was removed by the WTD on August, 10th. The longwave radiation sensor did not work properly on the August, 10th.

A calibration of the TSG data was done by comparing the measurements with the calibrated CTD data. It was found that salinity had to be corrected by 0.1 psu. The calibrated data were sent to the CORIOLIS Data Center, France with a temporal resolution of one minute.

On R/V METEOR meteorological parameters are also recorded by the German National Weather service (see report below). The sensors are on the platform of the mast at 40.2 m hight/above sea level. The weather station automatically calculated true wind speeds and directions.

The weather was during most of the cruise very good and did not much impact our operations. At the beginning of the cruise (first 2 days) we encountered some strong winds (Figure 5.5.1) associated with a low pressures system (Figure 5.5.2) but afterwards, relatively low winds speeds occurred.

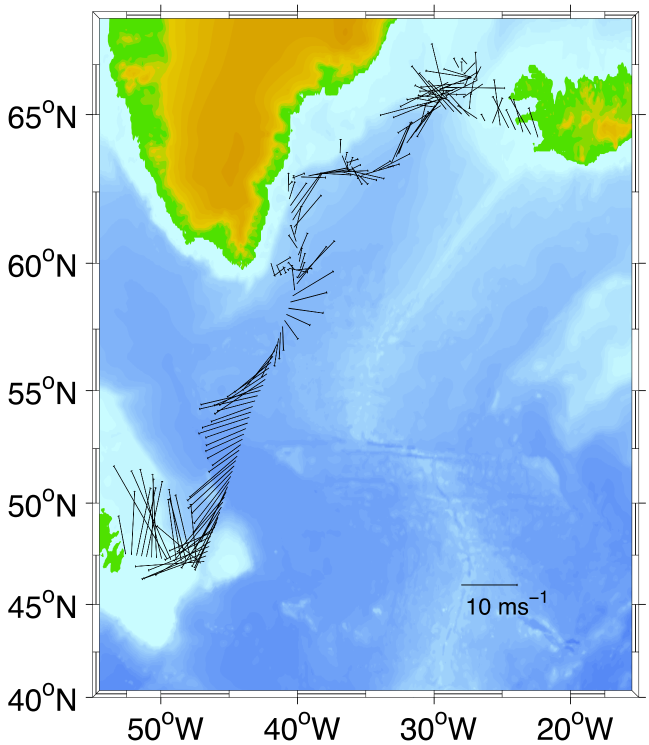

Fig. 5.5.1. Wind vectors along the cruise track of RV Meteor M852

Time series of selected observed and derived near surface and air/sea interface parameters are shown in Figure 5.5.1. to 5.5.3 along the cruise track. The heat fluxes were calculated according to Farell et al. (1996). Long wave radiation was calculated based on a black body radiation but with albedo parameterization and corrected for the observed incoming long wave radiation (e.g. due to clouds).

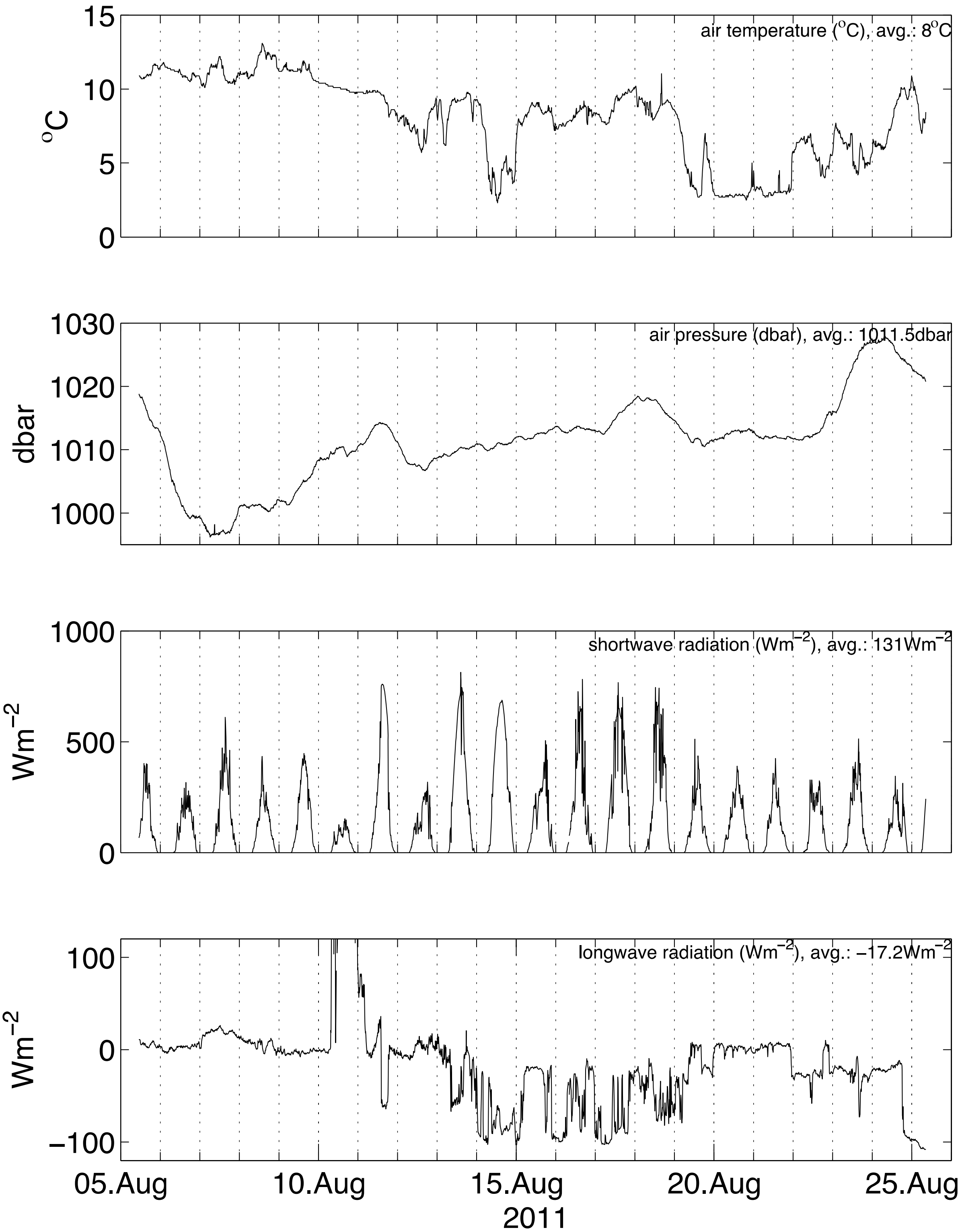

Fig. 5.5.2. Underway observations during M85/2 (top to bottom) air temperature, air pressure, shortwave radiation, net longwave radiation.

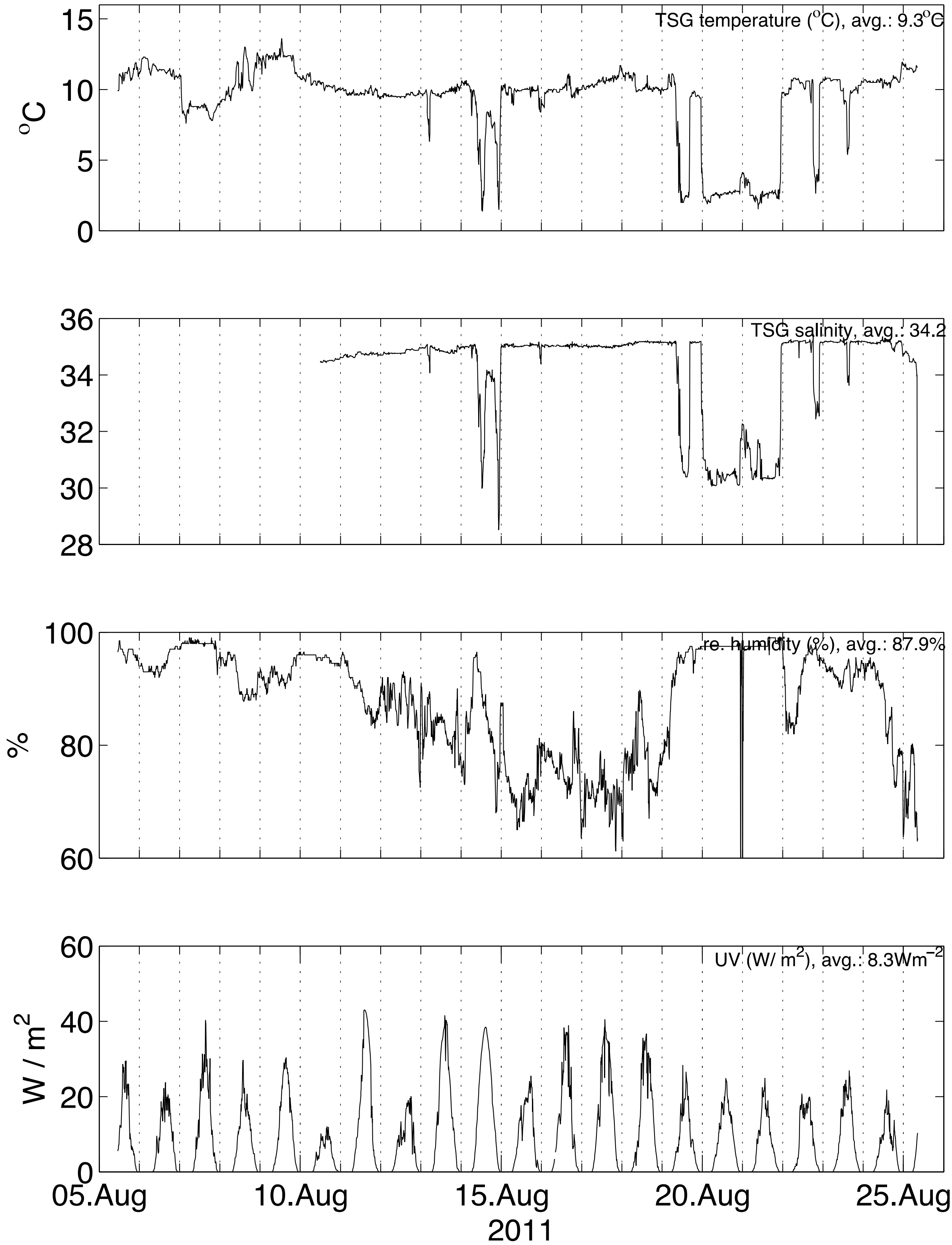

Fig. 5.5.3. (top to bottom) Thermosalinograph internal and external (sea surface) temperature, salinity, relative humidity, and UV radiation.

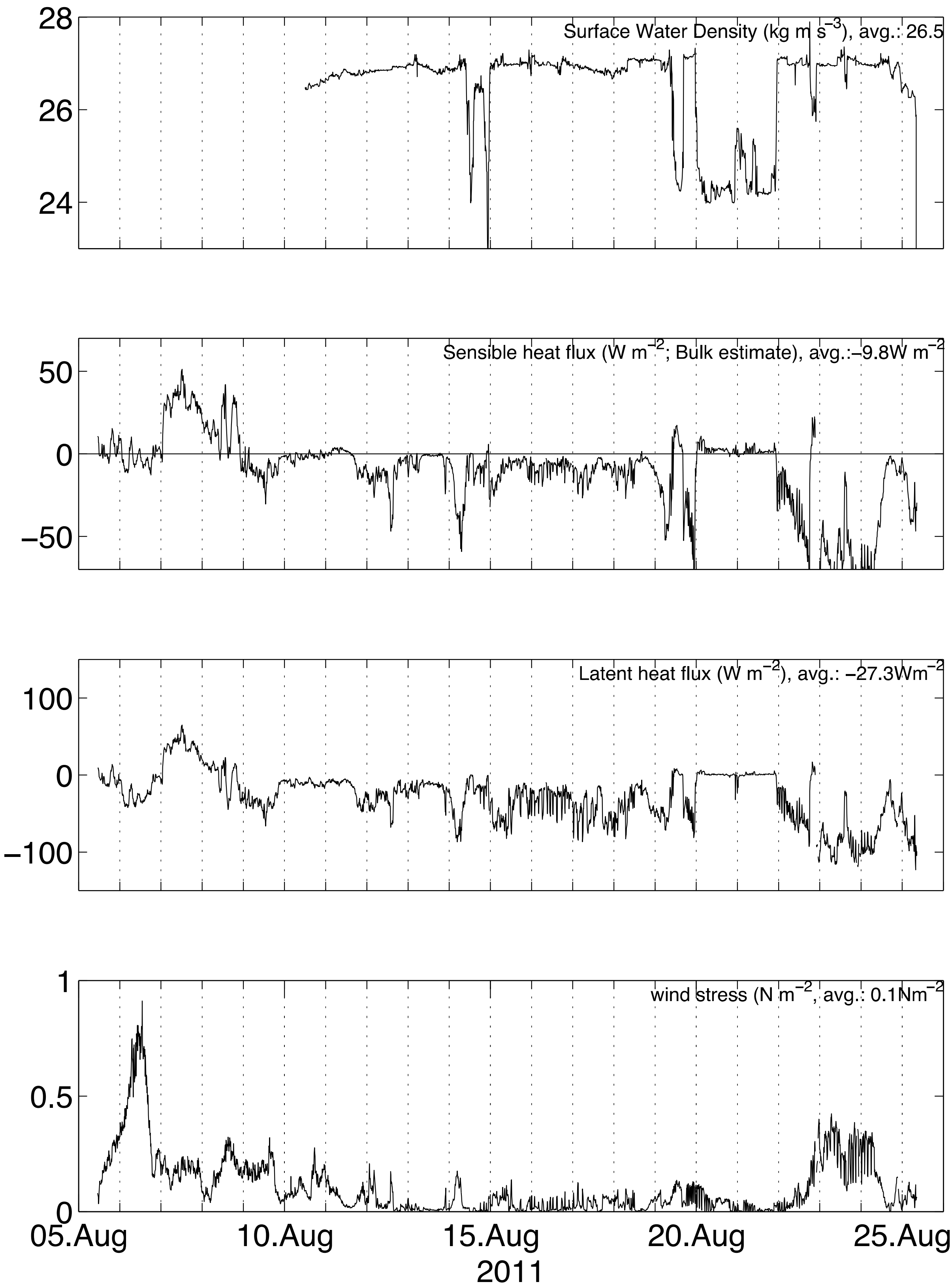

Fig. 5.5.4. (top to bottom) Surface density, sensible and latent heat flux and wind stress.

5.5 CFC/SF6 Sampling

(C. Hauer, M. Cienciala, D. Kieke, UNIHB)

Chlorofluorocarbons (CFC) belong to the group of anthropogenic transient trace gases with a high potential for global warming and for a destruction of the atmospheric ozone layer. Having been released into the atmosphere via industrial production since the 1930s they enter the ocean via gas-exchange processes. In the ocean they behave as inert gases. Active oceanic convection in the regions of deep water formation particularly facilitates a deep oceanic penetration of CFC to depth levels, where spreading of Labrador Sea Water (LSW) is typically observed. Since also source water masses feeding the Denmark Strait Overflow Water (DSOW) carry high concentrations of CFC, also the DSOW, forming the bottom layer in the Irminger and Labrador Seas, is enriched in CFC. As such, CFCs in the ocean are important markers for deep water formation and spreading.

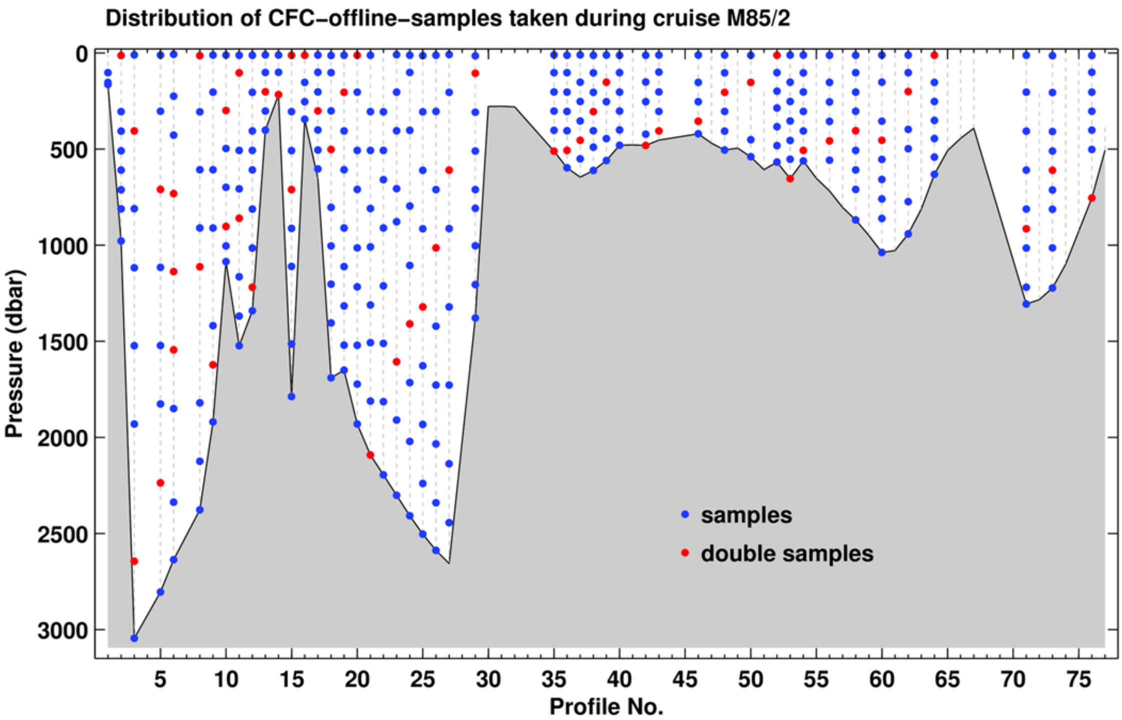

Figure 5.5.1.: Vertical distribution of CFC offline samples taken during cruise M85/2. Red markers highlight double samples.

During R/V METEOR M85/2, so-called CFC offline samples were taken with the aim to measure and analyze the content of the CFC components CFC-12 and CFC-11 in seawater. About 90ml of seawater were drawn from up to nine pre-cleaned 5l Niskin bottles attached to the carousel water sampler system. Water was sampled in so-called through-flow containers consisting of a glass ampoule attached to movable as well as fixed stainless steel tubings. During sampling the glass ampoule was flushed several times, thereby avoiding any contact to the surrounding atmosphere to prevent contamination of the sample. After sampling was finished the water sample was preserved by flame-sealing the neck of the glass ampoule. This was done by inserting CFC-free and purified nitrogen into the neck of the ampoule. As a result, a head-space built up inside the ampoule that allowed for any thermal expansion of the seawater sample and facilitated flame-sealing. At the end of the cruise samples were shipped to the University of Bremen, where they will be analyzed using a gas-chromatographic analytical system. Water samples were taken at selected hydrographic stations, but sampling covered all major sections conducted during R/V METEOR M85/2 (see Fig. 5.5.1). Altogether, about 360 seawater samples were taken, about 18% as double samples to allow for a later verification of the precision of the obtained CFC data. Together with CFC data obtained from the preceding cruise R/V METEOR M85/1, CFC inventories for the different deep water components will be calculated that allow, among others, estimating changes in the formation of LSW since 2009.

5.6 Argo float deployments

(V. Thierry, LPO, France & J. Karstensen, GEOMAR)

Two Argo floats with Oxygen Optodes have been deployed during R/V METEOR M85/2 (see Figure 5.6.1 and Table 5.6.1 for deployment information). The floats were PROVOR floats equipped with SeaBird SBE41CP temperature, conductivity and pressure sensors and Aanderaa Optode 4330. The deployment procedure was similar for both floats lifting them manually over the side. The only difference in deployment preparation was that the optode of float 1901210 was moistened only 1 hour before the deployment while the optode of float 1901209 was moistened 14hours before deployment. Apparently the first oxygen profiles looked different and which might be due to the different moistening.

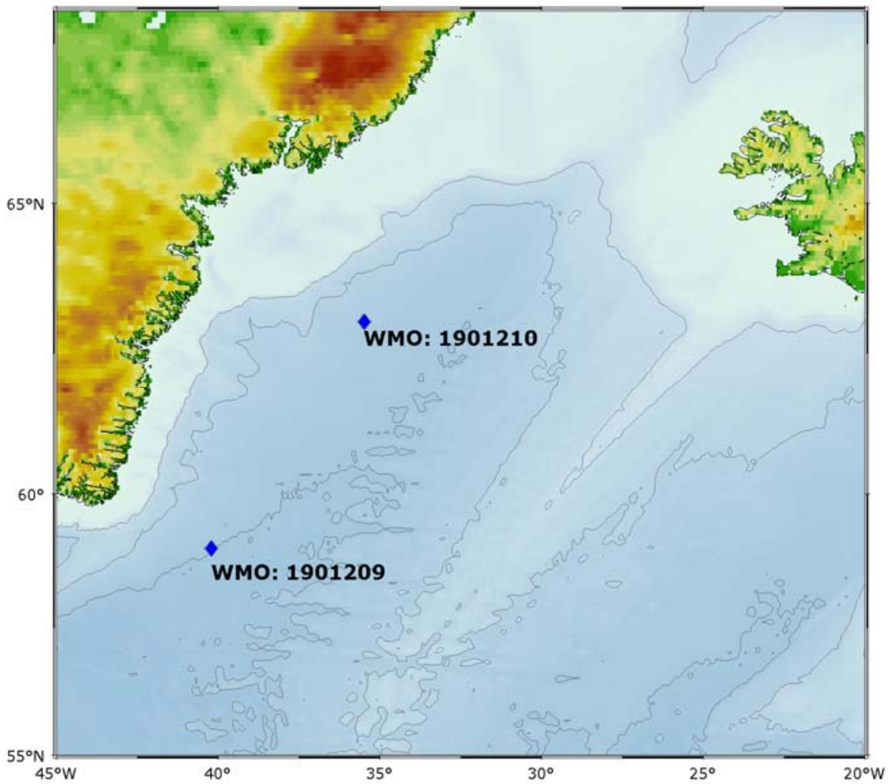

Fig. 5.6.1 Deployment positions and WMO number of the two Argo floats.

Table 5.6.1. Summary information on Argo float deployments during M85/2

ARGO PROJECT INFORMATION		
PI_NAME		**THIERRY-THEETTEN Virginie**
PROJECT_NAME		**Coriolis-OVIDE**
PLATFORM INFORMATION		
PLATFORM_MODEL	**PV_DO_BT**	**PV_DO_BT**
PLATFORM_MAKER	**NKE**	**NKE**
ARGOS PGM Number (Argos program)	**2412**	**2412**
FLOAT SAIL ID	**PVDO1006**	**PVDO1005**
SERIAL NUMBER	**OIN-10-S3-DO-06**	**OIN-10-S3-DO-05**
WMO NUMBER	**1901210**	**1901209**
ID ARGOS	**75311**	**75223**
BT NUMBER	**2010 06 11**	**2010 06 10**
DEPLOYMENT INFORMATION		
DEPLOY_MISSION (cruise_name)	**M852**	
DEPLOY_SHIP (ship_name)	**RV METEOR**	
DEPLOY_AVAILABLE_PROFILE_ID (CTD or XBT available: yes/no)	**ctd#27**	**ctd#03**
Magnet removal time (dd/mm/yyyy hh:mm UTC)	**17/08/2011 08:03**	**12/08/2011 00:50**
Argos messages and Valve clicks time (dd/mm/yyyy hh:mm UTC)	**17/08/2011 08:04 (Argos not checked)**	**12/08/2011 00:52 (Argos not checked)**
DEPLOYMENT TIME (dd/mm/yyyy hh:mm UTC)	**17/08/2011 08:13**	**12/08/2011 01:00**
LATITUDE	**63° 01.849'N**	**58° 59.96'N**
LONGITUDE	**35° 29.152'W**	**40° 12.33'W**
BATHY (m)	**2615m**	**3000m**
Operator name	**Johannes Karstensen**	**Johannes Karstensen**
Deployment method (release box, manual, expendable cardboard, etc…)	**Manual (robe), ship 2kn steaming**	**Manual (robe), ship 2kn steaming**
Meteorology	**Wind: 1m/s; no rain, wave:1m**	**Wind: 5m/s; no rain, wave: 2m**
Expected date of the first ascending profile (dd/mm/yyyy hh:mm UTC)	J + 1	J + 1

6 Ship's Meteorological Station

(A. Raeke)

In the morning of the 05th of August 2011 R/V METEOR left the port of St. John's within poor visibility and an overcast sky. In the beginning of the cruise a high extended from Greenland to Newfoundland leading to an easterly wind with strength 4 Bft.

On the evening of the 05th a low on the way to the south of Newfoundland approached the cruising area (towards Flamish Pass). The wind increased significantly.

On the 06th to the northern flank of the storm easterly winds of force 8, occasionally 9 with gusts 10 were experienced. With a sea of about 4 to 5m and an easterly headwind R/V METEOR was struggling. On the 07th the centre of the low approached the working area allowing the first mooring to bring up. The wind dropped to about Bft 6 with the windsea decreasing and an increasing swell of about 4 m. Until the 11th to southern Greenland the low accompanied R/V METEOR. On this passage R/V METEOR experienced winds from 6 to 7 BFT from the Northeast and a sea/swell of initially 4 to 5 m. Later the northerly wind dropped slowly and the sea/swell reached only 2 to 3m. In the vicinity of an upper air low R/V METEOR experienced some drizzle at times until the 12th, on the 10th it was continuously raining. From the 12th close to Greenland R/V METEOR was increasingly influenced by an intensifying Greenland high. Within low pressure differences calm weather conditions were experienced. During the following days until the 18th good working conditions prevailed. At first under the influence of a small low a little drizzle was experienced. Later the clouds were clearing leading to good visibility on Greenland. Weak winds and a swell of 0.5 to 1m were observed. In the early morning hours of the 14th R/V METEOR crossed a fog bank caused by the cold East Greenland current. The first icebergs were spotted surrounded by lots of Growlers.

In the night hours to the 15th polar light was spotted. On the 18th a storm depression was located to the southwest of Greenland bringing some showers. The working area was located between Iceland and Greenland. Within the area of the near-by low and a weakening high over Greenland the seastate increased only to 1.5 m with measured wind speeds of 5 to 6 Bft.

From the 19t^{h} in the last working area to the northwest of Iceland R/V METEOR experienced at first occasional, later on long lasting fog. The water and air temperature was only about 3 ° C. Until the 20th the wind abated to 3 to 4 Bft due to a low pressure gradient within the cruising area. From the 22th on the northern flank of a deepening storm low southwest of Iceland the northeasterly wind increased to 6 to 7 Bft with a sea of about 2 to 3m. Depending on the sea temperature occasional fog was experienced. From the 23th the Greenland high extended his influence southwards. The storm low only slowly moved to the southeast with winds about 6 Bft persisting until the 24th.

Later the wind abated to about 4 to 5 Bft. On the 25th R/V METEOR was on the edge of the Greenland high reaching the harbor of Reykjavik within fine weather conditions.

7 Station List R/V METEOR M85/2

Gear coding

RO: Rosette sampler
CTD: Conductivity/Temperature/Depth sonde
LADCP: lowered Acoustic Doppler Current Profiler
MOOR: Mooring operation
FLOAT: Argo float

Station No.		Date	Gear	Time	Latitude	Longitude	Depth	Remarks/Recovery
Event label	science	2011		[UTC]	[°N]	[°W]	[m]	
M852/849-1	1	05.08.	CTD/RO	13:07	47° 32.79' N	52° 35.23' W	171.3	
M852/850-1	2	07.08.	CTD/RO	08:06	47° 6.00' N	47° 6.79' W	978.2	
M852/852-1	FP 02-11	07.08.	MOR	11:33	47° 5.42' N	46° 52.65' W	1163.2	mooring deployment
M852/852-1	FP 01-11	07.08.	MOR	12:13	47° 6.02' N	46° 51.56' W	1160.7	mooring deployment
M852/853-1	3	11.08.	CTD/RO	23:52	59° 0.00' N	40° 11.99' W	3004.7	
M852/854-1	Argo	12.08.	FLOAT	02:07	58° 59.96' N	40° 12.33' W	5183.7	
M852/855-1	4	12.08.	CTD/RO	05:39	59° 40.18' N	39° 44.25' W	2781.2	
M852/856-1	CIS-10	12.08.	MOR	11:18	59° 41.37' N	39° 42.98' W	2770.1	mooring recovery
M852/857-1	5	12.08.	CTD/RO	12:34	59° 41.10' N	39° 43.55' W	2769.3	
M852/858-1	6	12.08.	CTD/RO	16:24	59° 46.00' N	40° 15.00' W	2606.6	
M852/859-1	8	12.08.	CTD/RO	21:22	59° 49.99' N	40° 50.01' W	2353.0	
M852/860-1	9	13.08.	CTD/RO	01:18	59° 55.00' N	41° 25.03' W	1898.9	
M852/861-1	10	13.08.	CTD/RO	04:34	60° 0.00' N	42° 0.00' W	2200.7	
M852/862-1	CIS-11	13.08.	MOR	17:44	59° 41.18' N	39° 43.80' W	2766.2	mooring deployment
M852/863-1	11	14.08.	CTD/RO	16:09	62° 54.99' N	40° 10.04' W	1510.2	
M852/864-1	12	14.08.	CTD/RO	19:19	62° 56.00' N	40° 14.96' W	1346.7	
M852/865-1	13	14.08.	CTD/RO	21:01	62° 56.95' N	40° 19.85' W	403.8	
M852/866-1	14	14.08.	CTD/RO	22:30	62° 58.42' N	40° 26.46' W	221.6	
M852/867-1	UK-2	15.08.	MOR	11:43	63° 16.73' N	35° 51.85' W	2336.5	mooring recovery
M852/868-1	G1-10	15.08.	MOR	13:38	63° 21.25' N	36° 6.96' W	2177.5	mooring recovery
M852/869-1	G1-11	15.08.	MOR	15:13	63° 21.25' N	36° 6.94' W	2174.4	mooring deployment
M852/870-1	UK1-10	15.08.	MOR	17:07	63° 28.89' N	36° 18.86' W	1955.7	mooring recovery
M852/871-1	F2-10	15.08.	MOR	18:48	63° 33.22' N	36° 30.62' W	1758.7	mooring recovery
M852/872-1	15	15.08.	CTD/RO	20:04	63° 34.00' N	36° 28.06' W	1768.3	
M852/873-1	16	15.08.	CTD/RO	23:24	63° 50.00' N	36° 58.10' W	346.5	
M852/874-1	17	16.08.	CTD/RO	01:01	63° 46.00' N	36° 50.51' W	646.7	
M852/875-1	18	16.08.	CTD/RO	02:55	63° 42.04' N	36° 43.13' W	1679.8	
M852/876-1	19	16.08.	CTD/RO	05:08	63° 38.00' N	36° 35.51' W	1632.0	
M852/877-1	20	16.08.	CTD/RO	07:53	63° 29.99' N	36° 20.52' W	1907.3	
M852/878-1	F2-11	16.08.	MOR	10:25	63° 33.05' N	36° 29.74' W	1762.5	mooring deployment
M852/879-1	UK1-11	16.08.	MOR	12:06	63° 29.05' N	36° 17.77' W	1960.9	mooring deployment
M852/880-1	21	16.08.	CTD/RO	13:30	63° 26.01' N	36° 13.01' W	2065.6	
M852/881-1	22	16.08.	CTD/RO	16:14	63° 22.00' N	36° 6.01' W	2169.6	
M852/882-1	UK2-11	16.08.	MOR	19:06	63° 16.83' N	35° 51.88' W	2335.8	mooring deployment
M852/883-1	23	16.08.	CTD/RO	20:41	63° 18.00' N	35° 59.00' W	2271.8	
M852/884-1	24	16.08.	CTD/RO	23:13	63° 13.99' N	35° 51.56' W	2376.9	
M852/885-1	25	17.08.	CTD/RO	01:39	63° 10.02' N	35° 43.96' W	2482.1	
M852/886-1	26	17.08.	CTD/RO	04:23	63° 6.00' N	35° 36.50' W	2554.3	
M852/887-1	27	17.08.	CTD/RO	07:01	63° 2.03' N	35° 28.83' W	2623.3	
M852/888-1	Argo	17.08.	Float	08:13	63° 1.92' N	35° 29.10' W	2622.1	slipped
M852/889-1	28	17.08.	CTD/RO	15:27	63° 20.00' N	33° 21.00' W	2788.4	
M852/890-1	DS5 -10	18.08.	MOR	09:48	65° 12.04' N	30° 0.21' W	0.0	mooring recovery
M852/891-1	DS6 -10	18.08.	MOR	10:47	65° 14.46' N	29° 59.94' W	0.0	mooring recovery
M852/892-1	DS7 -10	18.08.	MOR	11:34	65° 16.95' N	30° 0.07' W	0.0	mooring recovery
M852/893-1	29	18.08.	CTD/RO	12:12	65° 14.51' N	29° 59.99' W	1365.7	YOYO CTD Start
M852/893-1	29	19.08.	CTD/RO	03:10	65° 14.51' N	30° 0.01' W	1367.0	YOYO CTD Stopp
M852/894-1	DS 2-10	19.08.	MOR	12:16	66° 7.16' N	27° 17.12' W	0.0	Recovery DS210, failed
M852/895-1	30	19.08.	CTD/RO	18:30	65° 53.99' N	26° 19.51' W	280.1	
M852/896-1	31	19.08.	CTD/RO	19:19	65° 55.48' N	26° 26.00' W	279.4	
M852/897-1	32	19.08.	CTD/RO	20:12	65° 56.96' N	26° 32.53' W	281.3	
M852/898-1	33	19.08.	CTD/RO	21:00	65° 58.52' N	26° 39.06' W	275.4	

Station No.		Date	Gear	Time	Latitude	Longitude	Depth	Remarks/Recovery
Event label	**science**	**2011**		**[UTC]**	**[°N]**	**[°W]**	**[m]**	
M852/899-1	34	19.08.	CTD/RO	21:49	65° 59.99' N	26° 45.54' W	379.6	
M852/900-1	35	19.08.	CTD/RO	22:43	66° 1.49' N	26° 52.02' W	509.3	
M852/901-1	36	19.08.	CTD/RO	23:49	66° 3.00' N	26° 57.54' W	592.2	
M852/902-1	37	20.08.	CTD/RO	01:04	66° 4.49' N	27° 3.50' W	643.9	
M852/903-1	38	20.08.	CTD/RO	02:23	66° 6.00' N	27° 10.02' W	618.6	
M852/904-1	39	20.08.	CTD/RO	04:02	66° 7.50' N	27° 16.52' W	560.8	
M852/905-1	40	20.08.	CTD/RO	05:29	66° 9.00' N	27° 23.09' W	489.1	
M852/905-1	41	20.08.	CTD/RO	06:36	66° 10.49' N	27° 29.07' W	483.5	
M852/906-1	42	20.08.	CTD/RO	07:38	66° 12.02' N	27° 35.26' W	485.9	
M852/907-1	DS 2-10	20.08.	MOR	11:37	66° 7.28' N	27° 16.90' W	0.0	DS2-10 Dredgen/ Start
M852/907-1	DS 2-10	20.08.	MOR	18:55	66° 7.40' N	27° 15.70' W	0.0	DS2-10 Dredgen/ End
M852/909-1	43	20.08.	CTD/RO	21:41	66° 16.03' N	27° 50.41' W	457.2	
M852/910-1	44	20.08.	CTD/RO	23:01	66° 20.00' N	28° 5.46' W	340.6	
M852/911-1	45	21.08.	CTD/RO	00:14	66° 23.98' N	28° 20.50' W	327.8	
M852/912-1	46	21.08.	CTD/RO	03:52	66° 35.00' N	27° 8.00' W	435.7	
M852/913-1	47	21.08.	CTD/RO	04:58	66° 33.05' N	27° 0.02' W	476.4	
M852/914-1	48	21.08.	CTD/RO	06:04	66° 31.05' N	26° 52.00' W	511.2	
M852/915-1	49	21.08.	CTD/RO	07:12	66° 29.03' N	26° 43.92' W	500.1	
M852/916-1	50	21.08.	CTD/RO	08:21	66° 26.96' N	26° 35.06' W	549.3	
M852/917-1	51	21.08.	CTD/RO	09:48	66° 24.96' N	26° 26.00' W	616.4	
M852/918-1	DS 2-10	21.08.	MOR	12:57	66° 7.03' N	27° 16.46' W	577.3	DS2-10 Dredgen 2nd/ Start
M852/918-1	DS 2-10	21.08.	MOR	17:46	66° 7.08' N	27° 15.17' W	0.0	DS2-10 Dredgen 2nd/ End
M852/919-1	DS 2-11	21.08.	MOR	18:19	66° 7.23' N	27° 16.19' W	571.4	mooring deployment
M852/920-1	PIES DS2	21.08.	MOR	18:25	66° 7.25' N	27° 16.16' W	568.7	PIES deployment
M852/921-1	52	21.08.	CTD/RO	18:46	66° 7.25' N	27° 16.15' W	570.0	
M852/922-1	PIES DS1	21.08.	MOR	19:53	66° 4.58' N	27° 4.88' W	659.3	PIES deployment
M852/923-1	53	21.08.	CTD/RO	20:20	66° 4.52' N	27° 4.97' W	660.5	
M852/924-1	54	21.08.	CTD/RO	23:50	65° 37.03' N	27° 20.00' W	557.3	
M852/925-1	55	22.08.	CTD/RO	01:11	65° 37.00' N	27° 35.00' W	646.9	
M852/926-1	56	22.08.	CTD/RO	02:31	65° 36.99' N	27° 47.00' W	710.9	
M852/927-1	57	22.08.	CTD/RO	04:01	65° 37.00' N	28° 0.01' W	793.3	
M852/928-1	58	22.08.	CTD/RO	05:34	65° 37.04' N	28° 13.95' W	859.7	
M852/929-1	59	22.08.	CTD/RO	07:00	65° 37.01' N	28° 22.52' W	938.9	
M852/930-1	60	22.08.	CTD/RO	08:26	65° 37.00' N	28° 30.01' W	1025.0	
M852/931-1	61	22.08.	CTD/RO	09:59	65° 40.01' N	28° 33.06' W	1019.5	
M852/932-1	62	22.08.	CTD/RO	11:23	65° 42.99' N	28° 36.03' W	933.6	
M852/933-1	63	22.08.	CTD/RO	12:54	65° 45.99' N	28° 39.03' W	806.6	
M852/934-1	64	22.08.	CTD/RO	14:11	65° 49.00' N	28° 42.01' W	627.7	
M852/935-1	65	22.08.	CTD/RO	15:31	65° 52.00' N	28° 45.01' W	503.1	
M852/936-1	66	22.08.	CTD/RO	16:38	65° 54.92' N	28° 47.85' W	443.3	
M852/937-1	67	22.08.	CTD/RO	19:00	65° 57.95' N	28° 51.00' W	401.5	
M852/938-1	68	22.08.	CTD/RO	20:10	65° 59.96' N	29° 0.01' W	356.0	
M852/939-1	69	22.08.	CTD/RO	21:04	65° 59.98' N	29° 7.03' W	321.1	
M852/940-1	70	22.08.	CTD/RO	23:21	65° 43.67' N	29° 23.31' W	401.2	
M852/941-1	71	23.08.	CTD/RO	02:48	65° 24.00' N	28° 50.02' W	1291.3	
M852/942-1	72	23.08.	CTD/RO	05:13	65° 26.99' N	28° 55.01' W	1269.4	
M852/943-1	73	23.08.	CTD/RO	07:00	65° 29.99' N	29° 0.02' W	1208.8	
M852/944-1	74	23.08.	CTD/RO	09:13	65° 32.96' N	29° 5.06' W	1087.0	
M852/945-1	75	23.08.	CTD/RO	11:06	65° 35.96' N	29° 10.13' W	927.3	
M852/946-1	76	23.08.	CTD/RO	12:55	65° 38.96' N	29° 14.97' W	756.2	
M852/947-1	77	23.08.	CTD/RO	14:55	65° 41.94' N	29° 20.19' W	510.1	
M852/948-1	78	23.08.	CTD/RO	17:21	65° 40.00' N	29° 55.01' W	304.9	Meteor CTD, no lADCP
M852/949-1	79	23.08.	CTD/RO	18:42	65° 34.58' N	29° 49.04' W	347.2	Meteor CTD. no lADCP
M852/950-1	80	23.08.	CTD/RO	20:07	65° 29.97' N	29° 44.14' W	677.4	Meteor CTD. no lADCP
M852/951-1	81	23.08.	CTD/RO	21:39	65° 26.97' N	29° 42.04' W	890.0	Meteor CTD. no lADCP
M852/952-1	82	23.08.	CTD/RO	23:34	65° 23.96' N	29° 39.06' W	1091.2	Meteor CTD. no lADCP
M852/953-1	83	24.08.	CTD/RO	01:14	65° 20.96' N	29° 36.14' W	1262.8	Meteor CTD. no lADCP
M852/954-1	84	24.08.	CTD/RO	02:59	65° 17.95' N	29° 33.04' W	1418.8	Meteor CTD. no lADCP
M852/955-1	85	24.08.	CTD/RO	04:52	65° 15.00' N	29° 30.00' W	1514.1	Meteor CTD. no lADCP
M852/956-1	86	24.08.	CTD/RO	06:55	65° 12.00' N	29° 27.01' W	1582.4	Meteor CTD, no lADCP

8 Data and Sample Storage and Availability

The Kiel Data Management Team (KDMT) provides an information and data archival system where metadata of the onboard DSHIP-System is collected and publicly available. This Ocean Science Information System (OSIS-Kiel) is accessible for all project participants and can be used to share and edit field information and to provide scientific data, as they become available. The central system OSIS is providing information on granted ship time with information on the scientific program and the general details down to the availability of data files from already concluded cruises. The transparency on the research activities is regarded as an invitation to external scientists to start communication on collaboration on behalf of the newly available data.

The KDMT will take care as data curators to fulfill the here proposed data publication of the data in a World Data Center (e.g. PANGAEA) which will then provide long-term archival and access to the data. The data publication process will be based on the available files in OSIS and is therefore transparent to all reviewers and scientists. This cooperation with a world data center will make the data globally searchable, and links to the data owners will provide points of contact to project-external scientists. Availability of metadata in OSIS-Kiel (portal.geomar.de/osis): 2 weeks after the cruise. Availability of data in OSIS-Kiel (portal.geomar.de/osis): 6 months after the cruise. Availability of data in a WDC/PANGAEA (www.pangaea.de): 3 years after the cruise.

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10 References

During the cruise we followed the guide lines recently developed by the GO-SHIP group, particularly did we consider the guides for best practices:

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